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Conditions and Sustainability Status of Mangrove Island Karimun Big

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Abstract

The types of mangrove vegetation found on Karimun Besar Island consisted of A. lanalata, R. mangle, Xylocarpus sp., Nypa fruticans, Bruguiera sp., Lumnitzera racemosa. This species is spread unevenly on Karimun Besar Island. The highest INP was Xylocarpus species at station 3, West Meral District, which was 191.42%. The highest INP at station 1 type A. lanalata was 155.80%. The highest INP at station 2 type R. mangle was 155.44%. The highest INP at station 4 types of R. mangle is 150.93%. The highest INP at station 5 species A. lanalata was 162.91%. The highest INP at station 6 species of Xylocarpus was 198.82%. The highest INP at station 7 Bruguiera species is 137.51%. The highest INP at station 8 types of Lumnitzera racemosa is 175.35%. To manage the mangrove ecosystem on Karimun Besar Island, an integrated and sustainable management is needed. For this reason, an analysis of the sustainability status was carried out with 20 attributes and 4 dimensions, namely: the ecological dimension, the economic dimension, the social dimension and the legal and institutional dimension. The results of the analysis show that the multidimensional sustainability index is 41.44. Mangrove ecosystem management in a sustainable and integrated manner by prioritizing the management of the use of coastal areas, the availability of landfill waste, management of groundwater utilization, utilization of processed products from mangroves and mangrove rehabilitation.

Keywords
mangrove; rap SMILE; SDG-14

I. Introduction

Indonesia has around 3.2 million ha of mangroves, which is 22.6% of the world's total mangroves (Eddy et al. 2019). Mangrove ecosystems in Indonesia have decreased both in area and density due to land conversion for various purposes, such as agriculture, fisheries, settlements, industry and road infrastructure. The degradation of the mangrove ecosystem has an impact on coastal ecosystems and can also cause the sinking of very small islands. Human Resources (HR) is the most important component in a company or organization to run the business it does. Organization must have a goal to be achieved by the organizational members (Niati et al., 2021). Development is a change towards improvement. Changes towards improvement require the mobilization of all human resources and reason to realize what is aspired (Shah et al, 2020). The development of human resources is a process of changing the human resources who belong to an organization, from one situation to another, which is better to prepare a future responsibility in achieving organizational goals (Werdhiastutie et al, 2020).

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Law No. 1 of 2014 concerning the Management of Coastal Areas and Small Islands, states that the management of coastal areas and small islands is the process of planning, utilization, supervision and control of resources in coastal areas and small islands between sectors, between governments, between terrestrial ecosystems. and the sea and between science and management to improve people's welfare. The zoning plan is a plan that determines the direction of resource management by determining the structure and spatial planning of the area to be managed for use, limited use or cannot be utilized for activities (Sidqi et al. 2018).

Along with economic growth and population growth, development in coastal areas has increased utilization such as industrial areas, settlements, ports, ponds, which will result in ecological pressure on coastal ecosystems (Muhsimin et al. 2018). The increasing pressure on coastal ecosystems can threaten the sustainability of coastal resources (Dahuri 2001).

II. Research Method

Vegetation primary data was collected by using a combination of squared and plotted lines method. Each observation point is made of four lanes from the coast perpendicular to the mainland, cutting the mangrove from the front to the mainland, with a size of each transect line of 10 x 10 m. The observation point consists of 8 points with a minimum of 1 station 3 plots towards the ground.

The dimensions that will be studied in the sustainability status of the mangrove ecosystem are the ecological dimension, the economic dimension, the social dimension and the institutional dimension. The analysis uses a modified RapSMILE (Rapid Appraisal for Small Island) analysis (Susilo 2003). Collecting data on the sustainability of mangrove ecosystem management using an in-depth interview method using a questionnaire. 26 experts were assigned consisting of 1 DKP of Karimun Regency, 1 of the Environment Service, 1 of KPH Karimun, 1 person of UNRIKA Batam, 1 person of BAPPEDA of Karimun Regency, 1 person of DKP of Riau Islands Province and 1 person of Public Works Department of Kab. Karimun, 19 fishermen and community leaders.

Modification of indicators from RapSMILE consists of: Ecological dimensions (Mangrove land pressure, Availability of final disposal sites (TPA), Groundwater utilization conditions, Mangrove rehabilitation, Mangrove cover. Economic dimensions (Accessibility of mangrove areas, Utilization of mangrove ecosystem products by the community, Average income of the community on UMR, local government budget for mangrove ecosystem management, amount of subsidy) Social dimension (Community knowledge about mangroves, Public awareness of the importance of protecting mangroves, Conflicts over the use of mangrove ecosystems, community education level, Attention of mangrove researchers) Institutional dimension (Availability of management regulations mangrove ecosystem, Involvement of community institutions in management, Coordination between stakeholders, Monitoring and supervision, Compliance with regulations for the preservation of mangrove ecosystems) From the RAPSMILE analysis, it provides sustainability results in every aspect studied in the form of a scale of 0 to ai 100%, if the system under study has an index value of more than 75% then the development is sustainable (sustainable) and vice versa if it is less than 75% then the development is not sustainable (unsustainable). To test the error value, Monte Carlo analysis was performed, with 25 repetitions (Kavanagh & Pitcher 2001). The stress value is denoted (S) and the coefficient of determination (R2). Good analysis results are indicated by low stress $S < 0.25$ and high R2 value (Fauzi & Anna 2002).

III. Result and Discussion

The research location is on Karimun Besar Island, Karimun Regency, Riau Islands Province with coordinates of $00^0$24'36" North Latitude - $01^0$13'12" North Latitude and $103^0$13'12" East Longitude - $104^0$00'36" East Longitude. The sample point for mangrove observations based on the processed results of the Landsat 7 ETM+ satellite image is:

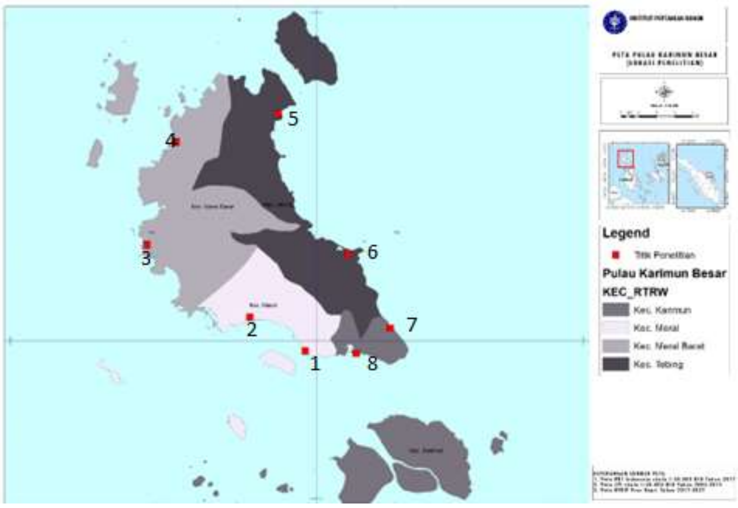

Figure 1*. Research Location on Karimun Besar Island (Source: Primary Data)*

The results of the observation of water quality parameters at 8 stations were observed to be samples in the study as follows:

Table 1. Water Quality Parameters for Research Locations on Karimun Besar Island

Station	Parameter		
	pH	Salinitas (‰)	substrat
1	25	6	mud
2	25	6	mud
3	25	6,8	sandy mud
4	26	6,8	mud
5	26	7	hard mud
6	25	6	sandy mud
7	25	6,8	hard mud
8	25	6,8	hard mud

Source: Primary data

The types of mangrove vegetation are *A. lanalata*, *R. mangle*, *Xylocarpus* sp., *Nypa fruticans*, *Bruguiera*, *Lumnitzera racemosa*. Mangrove species are spread unevenly at each observation station. The density of mangrove species found at each station using a 10 m x 10 m transect, it will show the INP value of each station:

Table 2. INP Station 1

Type of mangrove	n	K	KR	F	FR	D	DR	INP
		(stem/ha)	%		%	m2/ha	%	%
				Tree				
A. lanalata	20	2.000,00	57,14	0,75	37,50	45,12	61,16	155,80
R. mangle	14	1.400,00	40,00	1,00	50,00	26,02	35,27	125,27
Xylocarpus	1	100,00	2,86	0,25	12,50	2,63	3,57	18,93
				Stake				
A. lanalata	16	6.400,00	47,06	0,75	37,50			84,56
R. mangle	17	6.800,00	50,00	1,00	50,00			100,00
Xylocarpus	1	400,00	2,94	0,25	12,50			15,44
				Seedling				
A. lanalata	3	30.000,00	37,50	0,50	66,67			104,17
R. mangle	5	50.000,00	62,50	0,25	33,33			95,83

Source: Primary data

The Important Value Index is the sum of relative density, relative frequency and relative dominance. INP describes the level of importance or ecological value of the species in a group. Station 1 for the highest tree group was *A. lanalata*, which was 155.80%, the highest sapling group was *R. mangle*, which was 100%, and the highest seedling group was *A. lanalata*, which was 104.17%. The highest density value for the tree group of *A. lanalata* was 2,000 stems/ha, the sapling group had the highest density value of *R.mangle*, which was 6,800 stems/ha, and the seedling group had the highest density of *A. lanalata*, which was 30,000 stems/ha.

INP and the highest density at station 2 for the tree group, namely *R.mangle* species at 155.44% and 900 stems/ha, for the INP sapling group and the highest density at *Xylocarpus* species at 97.89% and 4,400 stems/ha, the seedling group INP and the highest density was in the type of *R.mangle* at 200% and 20,000 stems/ha.

Table 3. INP Station 2

Type of mangrove	n	K	KR	F	FR	D	DR	INP
		(stem/ha)	%		%	m2/ha	%	%
				Tree				
R. mangle	5	900,00	64,29	1,00	50,00	24,77	41,15	155,44
Xylocarpus	9	200,00	35,71	1,00	50,00	35,42	58,85	144,56
				Stake				
R. mangle	11	2.000,00	26,32	1,00	40,00			66,32
Xylocarpus	5	4.400,00	57,89	1,00	40,00			97,89
Nypa fruticans	3	1.200,00	15,79	0,50	20,00			35,79
				Seedling				
R. mangle	2	20.000,00	100,00	0,50	100,00			200,00

Source: Primary data

INP and density at station 2 of the highest tree groups were *R. mangle* at 155.44% and 900 stems/ha. The INP and the highest density of the sapling group on *Xylocarpus* species were 97.89% and 4,400 stems/ha. The INP and the highest density of seedling groups in the *R.mangle* species were 200% and 20,000 stems/ha.

Table 4. INP Station 3

Type of mangrove	n	K	KR	F	FR	D	DR	INP
		(stem/ha)	%		%	m2/ha	%	%
				Tree				
R. mangle	8	800,00	33,33	0,70	40,00	37,80	35,24	108,58
Xylocarpus	16	1.600,00	66,67	1,00	60,00	69,45	64,76	191,42
				Stake				
R. mangle	6	2.400,00	16,67	1,00	42,86			59,52
Xylocarpus	22	8.800,00	61,11	1,00	42,86			103,97
Bruguiera	8	3.200,00	22,22	0,33	14,29			36,51
				Seedling				
A. lanalata	6	60.000,00	42,86	0,33	33,33			76,19
Xylocarpus	8	80.000,00	57,14	0,67	66,67			123,81

Source: Primary data

The highest INP and density were at station 3 tree groups, namely *Xylocarpus* species at 191.42% and 1,600 stems/ha. The highest INP and sapling group density were *Xylocarpus* species of 103.97% and 8,800 stems/ha. The highest INP and density of seedling groups were *Xylocarpus* at 123.81% and 80,000 stems/ha.

INP and density at station 4 were the highest for tree groups, namely *R. mangle* at 150.93% and 2,500 stems/ha. The INP and the highest density of the sapling group were *R. mangle* at 106.25% and 7,200 stems/ha. The highest INP and density of seedling groups were *R. mangle* at 149.02% and 140,000 stems/ha.

Table 5. INP Station 4

Type of mangrove	n	K	KR	F	FR	D	DR	INP
		(stem/ha)	%		%	m2/ha	%	%
				Tree				
A. lanalata	5	500,00	16,67	1,00	50,00	6,70	17,60	149,07
R. mangle	25	2.500,00	83,33	1,00	50,00	31,40	82,40	150,93
			Stake					
A. lanalata	14	5.600,00	43,75	1,00	50,00			93,75
R. mangle	18	7.200,00	56,25	1,00	50,00			106,25
			Semai					
A. lanalata	3	30.000,00	17,65	0,50	33,33			50,98
R. mangle	14	140.000,00	82,35	1,00	66,67			149,02

Source: Primary data

The highest INP and density at station 5 tree groups were *A. lanalata* at 162.91% and 1,300 stems/ha. The INP and the highest density of the sapling group were *A. lanalata* at 166.67% and 10.400 stems/ha. The INP and the highest density of seedling clusters were *A. lanalata* at 146.43% and 50,000 stems/ha.

Table 6. INP Station 5

Type of mangrove	n	K	KR	F	FR	D	DR	INP
		(stem/ha)	%		%	m2/ha	%	%
				Tree				
A. lanalata	13	1.300,00	86,67	1,00	66,70	18,72	90,45	162,91
R. mangle	2	200,00	13,33	0,50	33,30	1,98	9,55	137,09
				Stake				
A. lanalata	26	10.400,00	86,67	1,00	80,00			166,67
R. mangle	4	1.600,00	13,33	0,25	20,00			33,33
				Seedling				
A. lanalata	5	50.000,00	71,43	0,75	75,00			146,43
R. mangle	2	20.000,00	28,57	0,25	25,00			53,57

Source: Primary data

INP and density at station 6 were the highest for tree groups, namely *Xylocarpus* at 198.82% and 1,700 stems/ha. The INP and the highest density of the sapling group were *Xylocarpus* at 103.85% and 2,800 stems/ha. The INP and the highest density of the seedling group were *Xylocarpus* at 121.43% and 50,000 stems/ha.

Table 7. INP Station 6

Type of mangrove	n	K	KR	F	FR	D	DR	INP
		(stem/ha)	%		%	m2/ha	%	%
				Tree				
A. lanalata	2	200,00	8,33	0,33	16,70	3,05	6,69	31,73
R. mangle	5	500,00	20,83	0,67	33,30	6,98	15,32	69,45
Xylocarpus	17	1.700,00	70,83	1,00	50,00	35,55	77,99	198,82
				Stake				
R. mangle	2	800,00	15,38	0,33	25,00			40,38
Xylocarpus	7	2.800,00	53,85	0,67	50,00			103,85
Nypa fruticans	4	1.600,00	30,77	0,33	25,00			55,77
				Seedling				
A. lanalata	1	10.000,00	14,29	0,33	25,00			39,29
R. mangle	1	10.000,00	14,29	0,33	25,00			39,29
Xylocarpus	5	50.000,00	71,43	0,67	50,00			121,43

Source: Primary data

Table 8. INP Station 7

Type of mangrove	n	K	KR	F	FR	D	DR	INP
		(stem/ha)	%		%	m2/ha	%	%
				Tree				
A. lanalata	3	300,00	25,00	0,67	40,00	2,71	14,66	79,66
R. mangle	2	200,00	16,67	0,33	20,00	1,68	9,10	45,77
Xylocarpus	1	100,00	8,33	0,33	20,00	1,61	8,72	37,06
Bruguiera	6	600,00	50,00	0,33	20,00	12,48	67,51	137,51
			Stake					
A. lanalata	14	5.600,00	32,56	1,00	33,33			65,89
R. mangle	14	5.600,00	32,56	1,00	33,33			65,89
Xylocarpus	12	4.800,00	27,91	0,67	22,22			50,13
Bruguiera	3	1.200,00	6,98	0,33	11,11			18,09
			Seedling					
A. lanalata	10	100.000,00	37,04	0,67	33,33			70,37
R. mangle	15	150.000,00	55,56	1,00	50,00			105,56
Bruguiera	2	20.000,00	7,41	0,33	16,67			24,07

Source: Primary data

The highest INP and density at station 7 tree groups were *Bruguiera* sp. of 137.51% and 600 stems/ha. The INP and the highest density of the sapling group were *A. lanalata* and *R. mangle* of 65.89% and 5,600 stems/ha. INP and the highest density of the seedling group were *R. mangle* of 105.56% and 150,000 stems/ha.

Table 9. INP Station 8

Type of mangrove	n	K	KR	F	FR	D	DR	INP
		(stem/ha)	%		%	m2/ha	%	%
				Tree				
A. lanalata	16	1.600,00	45,71	1,00	50,00	24,29	28,94	124,65
Lumnitzera racemo	19	1.900,00	54,29	1,00	50,00	59,65	71,06	175,35
				Stake				
A. lanalata	10	4.000,00	62,50	0,50	40,00			102,50
R. mangle	2	800,00	12,50	0,25	20,00			32,50
Lumnitzera racemo	4	1.600,00	25,00	0,50	40,00			65,00
				Seedling				
A. lanalata	7	70.000,00	35,00	0,50	33,33			68,33
R. mangle	1	10.000,00	5,00	0,25	16,67			21,67
Lumnitzera racemo	12	120.000,00	60,00	0,75	50,00			110,00

Source: Primary data

The highest INP and density at station 8 tree groups were *Lumnitzera racemosa* at 175.35% and 1,900 stems/ha. The INP and the highest density of the sapling group were *A. lanalata* of 102.50% and 4,000 stems/ha. The INP and the highest density of the seedling group were *Lumnitzera racemosa* at 110% and 120,000 stems/ha.

From all stations, the Karimun sub-district tree group at station 7 has the lowest highest density level, namely the *Bruguiera* species of 700 stems/ha. The highest density of all tree groups was found at station 4 in West Meral District, namely *R. mangle* species as much as 2,500. Station 7 is located in Karimun District where the area is used for other utilization areas for coastal area business areas, urban settlements and there is a coal-fired power plant, resulting in at least mangrove growth. According to Yanti *et a*l. (2016) the low species diversity is caused by the large pressure of activities carried out by humans that can change the mangrove ecosystem into other use areas, such as industry and settlements. Changes in mangrove habitat can be caused by the effects of extreme changes such as high temperatures, therefore to survive mangroves must be able to adapt. Ecological pressures that have been increasing over the last 20 years can be seen from the indicators of decreasing mangrove area and pollution. Efforts to restore habitat and diversity of native mangrove species need to be carried out, such as reforestation of damaged mangroves, using native local species, restoring native species from planting not from native species of the place. The mangrove rehabilitation approach can be carried out using several methods: 1) The conservation approach aims to restore the value of the original species. 2) Protection of coastal areas in the form of reforestation in areas prone to abrasion, storm-prone, and tides as coastal protection. 3) Multipurpose system, this method is used if the damage to the mangrove ecosystem has affected the use of mangrove land (Field 1998).

The type of *R. mangle* in Meral Barat District at station 4 has a dominance of 82.40% which is associated with the *Avicennia* type of fire with soft and deep mud as a substrate. The location of station 4 is behind a hill with the shipbuilding industry of PT Sembawang and PT Oil Thanking and is used as a traditional fishing base. According to Kitamura *et al.* (2003) *Avicennia* species associated with *Rhizophora* are often found growing in coastal areas jutting into the sea with high salinity. This species has strong roots and can withstand the blows of the tides.

3.1 Sustainability Status

Sustainability status is based on 20 attributes from 4 dimensions. The multidimensional sustainability index of 41.44 means that it is less sustainable as shown in Figure 2.

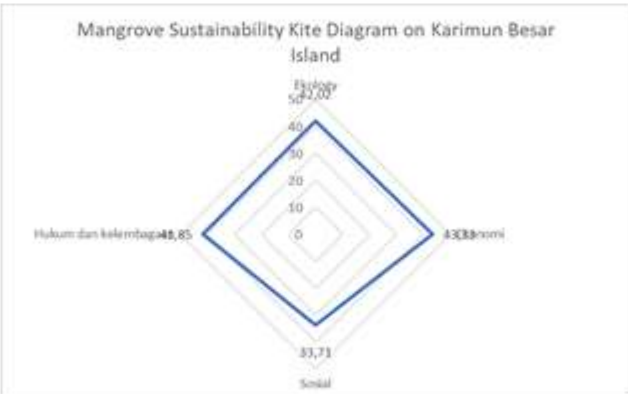

Figure 2. *Elevated Diagram of Mangrove Sustainability on Karimun Besar Island (Source: Primary Data)*

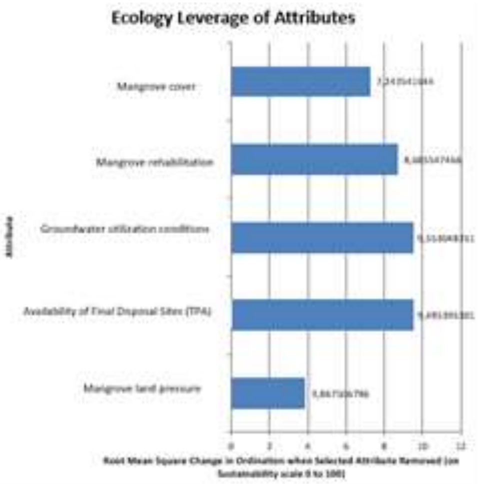

Figure 3. *Levers of the Ecological Dimension*

The economic dimension has a sustainability index value of 43.33 meaning that it is less sustainable, where there are two leverage factors, namely: 1) the average community income towards the UMR and 2) the use of mangrove ecosystem products by the community.

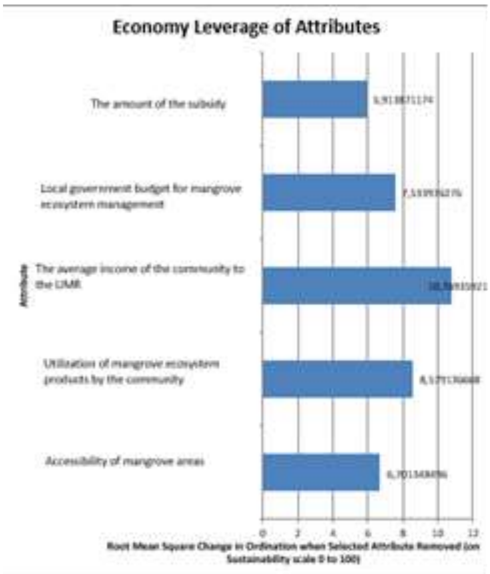

Figure 4. *Levers of the Economic Dimension*

The social dimension has a sustainability index value of 33.71 meaning less sustainable, where there are two leveraging factors, namely: 1) community knowledge about mangroves and 2) public awareness of the importance of protecting mangroves.

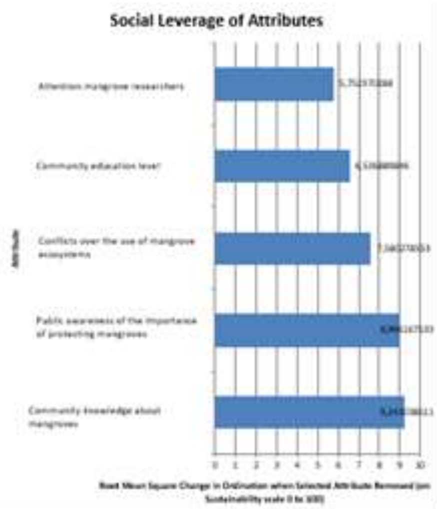

Figure 5. *Levers of the Social Dimension*

The legal and institutional dimensions have a sustainability index value of 41.85 meaning less sustainable, where there are two leveraging factors, namely: 1) coordination between stakeholders and 2) monitoring and supervision.

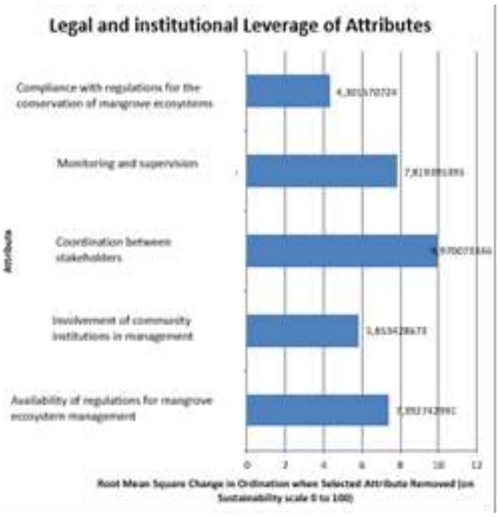

Figure 6. *Leveraging Legal and Institutional Dimensions*

The stress value (S) for each dimension and multidimensional <0.25, means that the stress analysis value is quite adequate. The value of the coefficient of determination (R^2) is good if it gets a value close to 1, so the values of S and R^2 show the attributes in the analysis are quite good at explaining all dimensions. Monte Carlo analysis was used to test the level of confidence in each dimension (Table 10), the small difference in index values between RapSMILE and Monte Carlo means that the analysis has a high level of confidence in analyzing sustainability status (Table 11).

Table 10. RapSMILE 4-dimensional and multidimensional sustainability index

Dimension	Stress	R^2	Sustainability Index
Ecology	0,23	0,89	42,02
Economy	0,22	0,87	43,33

social	0,23	0,90	33,71
Law and Institutions	0,19	0,91	41,85
Multidimensional	0,15	0,91	41,44

Table 11. Difference between *RapSMILE* and Monte Carlo Sustainability Indexes

Sustainability Index between *RapSMILE* and Montecarlo			
Dimension	RapSMILE	Montecarlo	Difference
Ecology	42,02	42,29	0,26
Economy	43,33	43,84	0,51
Social	33,71	34,57	0,86
Law and Institutions	41,85	42,15	0,30

3.2 Ecological Dimensions

Utilization of groundwater is a sensitive attribute. Karimun Besar Island is a small island that is vulnerable to groundwater utilization, from BPS data of Karimun Regency, PDAM water sales in 2020 were 1,443,609 m3 with a total of 8,379 customers. The domination of PDAM Tirta Karimun customers is dominated by households as much as 75.99%, the category of commercial customers by 21.77%, and the category of social, government agencies, industry as much as 2.24%. The total population on Karimun Besar Island is 145,018 people. Utilization of groundwater in Karimun Besar Island dominates in the use of household consumption.

Management in the utilization of groundwater is very important to avoid the occurrence of land subsidiary in the form of void of water mass in the soil and the occurrence of seawater intrusion in coastal areas. Waste management on Karimun Besar Island is carried out by means of landfill (sanitary landfill) with previously separated organic and inorganic waste. The number of landfills is only one in the Sememal area, West Meral District with an area of 94,413 m^2. It is necessary to use technology in waste management, such as the utilization of waste into gas for households. The number of coastal communities who throw garbage in the sea, it is necessary to enforce the law so that pollution in the sea can be reduced.

3.3 Economic Dimensions

The number of small fishermen on Karimun Besar Island is 1,316 fishermen. Karimun District 416 fishermen, Meral District 145 fishermen, Tebing District 465 fishermen and West Meral District 290 fishermen. The number of small fishermen on Karimun Besar Island is 25% of the number of fishermen in Karimun Regency. According to Law No. 11 of 2020, the category of small fishermen is fishermen who catch fish to fulfill their daily needs, both those who do not use fishing vessels and those who use fishing vessels with a maximum size of 10 (ten) gross tons (GT). Respondents assessment of the income of small fishermen ranges from Rp. 1,000,000 to Rp. 2,000,000 per month, where the UMR of the Riau Islands Province is Rp. 3,005,383, meaning that the income of small fishermen on Karimun Besar Island is mostly below the provincial UMR average. The results of the analysis of perceptions of small fishermen earning above Rp. 2,000,000 as much as 32%, small fishermen earning Rp. 1,500,000 to Rp. 2,000,000 as much as 49%, fishermen earning Rp. 1,000,000 to Rp. 1,500,000 as much as 13% , fishermen earn Rp. 500,000 to Rp. 1,000,000 as much as 4% and fishermen who earn less than Rp. 500,000 as much as 1%.

Utilization of the results of the mangrove ecosystem has not been used optimally. The Wanaja Karimun Cooperative is a cooperative that oversees the charcoal kitchen in Karimun district. The Karimun Regency HTR business permit has an area of 9,335 ha which includes 7 sub-districts, namely: Moro District, Buru District, Durai District, North Kundur District, Kundur District, Karimun District and West Kundur District, in accordance with the Decree of the Regent of Karimun Regency No. 192 of 2010 (Wulandari 2019).

Table 12. Number of Panglong Charcoal Kitchen

District	Panglong owner	Production capacity	Number of furnaces
	KK	(m^3/year)	
Buru	5	500 s/d 1.000	15
Karimun	1	500	6
Kundur	10	300 s/d 750	34
Moro	14	500 s/d 750	35
Durai	3	500	4

Source: Wulandari 2019

Utilization of results from mangroves should not only come from charcoal kitchens that cut mangrove trees, but can be done from the side of ecotourism or culinary processed mangroves in the form of lunkhead. Increased training and mentoring needs to be done, considering the geographical location of Karimun Island is on the border with Singapore and Malaysia. Tourism opportunities are so great by taking advantage of the natural beauty that is maintained.

3.4 Social Dimensions

Respondents still need to increase the socialization of the functions and benefits of the mangrove ecosystem. Mangrove management that is sustainable and can improve the lives of fishing communities is urgently needed. Socialization and education to coastal communities is a horizontal communication mechanism, so that people understand their rights and obligations in conserving mangrove ecosystems.

The results of the analysis of community perceptions of 90 respondents were obtained, the community agreed that mangrove ecotourism was good for improving the welfare of coastal communities by 62% and 33% strongly agreed, there were 3% of fishermen who did not want tourism in their location, because the location of Karimun District was already narrow for settlements and fishing bases. . Tourist locations in Meral Barat District and Karimun District allow development. As many as 79% of fishermen agree that mangrove ecotourism is used as a place for education for school children and research for mangrove conservation in Karimun.

As many as 61% of fishing communities want to play a role in mangrove management, participate in maintaining, planting and utilizing processed products from the mangroves themselves. As many as 68% of fishermen agree that the damage to the mangrove ecosystem is caused by the conversion of land into industrial, residential and business areas. The need for CSR planting mangroves around the location of industrial areas and business areas, so that the green belt line is maintained for the preservation of Karimun Besar Island.

3.5 Legal and Institutional Dimensions

Coordination between central and local governments as well as coordination between governments in the Karimun Regency area is often carried out, but the results of the meeting activities have not been fully implemented together, so that the attributes of coordination between stakeholders become levers in increasing the sustainability of the legal and institutional dimensions. Mangrove management overlaps often occur between the Ministry of Environment and Forestry (KLHK), the Ministry of Sea Transportation and the Ministry of Maritime Affairs and Fisheries. The Ministry of Transportation has the function of managing the utilization of the DLKr/DLKp area on small islands while the KKP has duties and functions regarding the sustainability and stability of coastal and marine resources.

Supervision in the management and utilization of mangroves in Karimun Regency is carried out by the Ministry of Environment and Forestry, Ministry of Marine Affairs and Fisheries, Regional Government of Karimun Regency and the Peat and Mangrove Restoration Agency. The secondary mangrove forest area is under the control and management of the Ministry of Maritime Affairs and Fisheries and the Karimun Regency Government, supervision and management of other utilization areas that contain mangroves, with the drafting of Law No. 11 of 2020 concerning Job Creation, article 16 paragraph (2) which reads that everyone does the use of space from coastal waters as referred to in paragraph (1) must fulfill business permits related to utilization at sea from the Central Government. With the formation of the KKPRL regulations, it is hoped that the utilization of coastal areas will be more maintained and adapted to the carrying capacity of the area.

The results of the perception analysis stated that 90 respondents regarding law enforcement for people who damage mangroves disagreed as much as 38%, disagreed as much as 23% and agreed to enforce the law as much as 17%. Considering that there are still many coastal communities who use mangrove wood for construction activities or firewood. So it is necessary to zoning mangrove management which areas may be used in a limited manner and areas that must be preserved.

IV. Conclusion

The types of mangrove vegetation found on Karimun Besar Island consisted of A. lanalata, R. mangle, Xylocarpus sp., Nypa fruticans, Bruguiera sp., Lumnitzera racemosa. This species is spread unevenly on Karimun Besar Island. The highest INP was Xylocarpus species at station 3, West Meral District, which was 191.42%. The highest INP at station 1 type A. lanalata was 155.80%. The highest INP at station 2 type R. mangle was 155.44%. The highest INP at station 4 types of R. mangle is 150.93%. The highest INP at station 5 species A. lanalata was 162.91%. The highest INP at station 6 species of Xylocarpus was 198.82%. The highest INP at station 7 Bruguiera species is 137.51%. The highest INP at station 8 types of Lumnitzera racemosa is 175.35%.

Based on the standard criteria and guidelines for mangrove damage, Minister of Environment Decree No. 201 of 2004, for station 1 is categorized as dense mangrove area. for station 2, it is categorized as moderate mangrove area with a density of 1000-1500 stems/ha. For station 3, it is categorized as a meeting area. Station 4 is categorized as a dense mangrove area. Station 5 is categorized as a medium mangrove area. Station 6 is categorized as dense mangrove area. Station 7 is categorized as damaged mangrove area and station 8 is categorized as moderate. Station 7 and station 8 have a rare density because the area is used as a business area, residential area and there is a coal-fired power plant, so it is necessary to improve the mangrove ecosystem in order to preserve the function of mangroves on the island of Karimun Besar.

The sustainability status of mangrove ecosystem management on Karimun Besar Island is 41.44 which means that it is less sustainable, as well as the ecological, economic, social and legal dimensions of the institution which have a less sustainable index.

Mangrove ecosystem management in a sustainable and integrated manner by prioritizing the management of the use of coastal areas, the availability of landfill waste, management of groundwater utilization, utilization of processed products from mangroves and mangrove rehabilitation.

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